Deep Decarbonization Pathways in Japan

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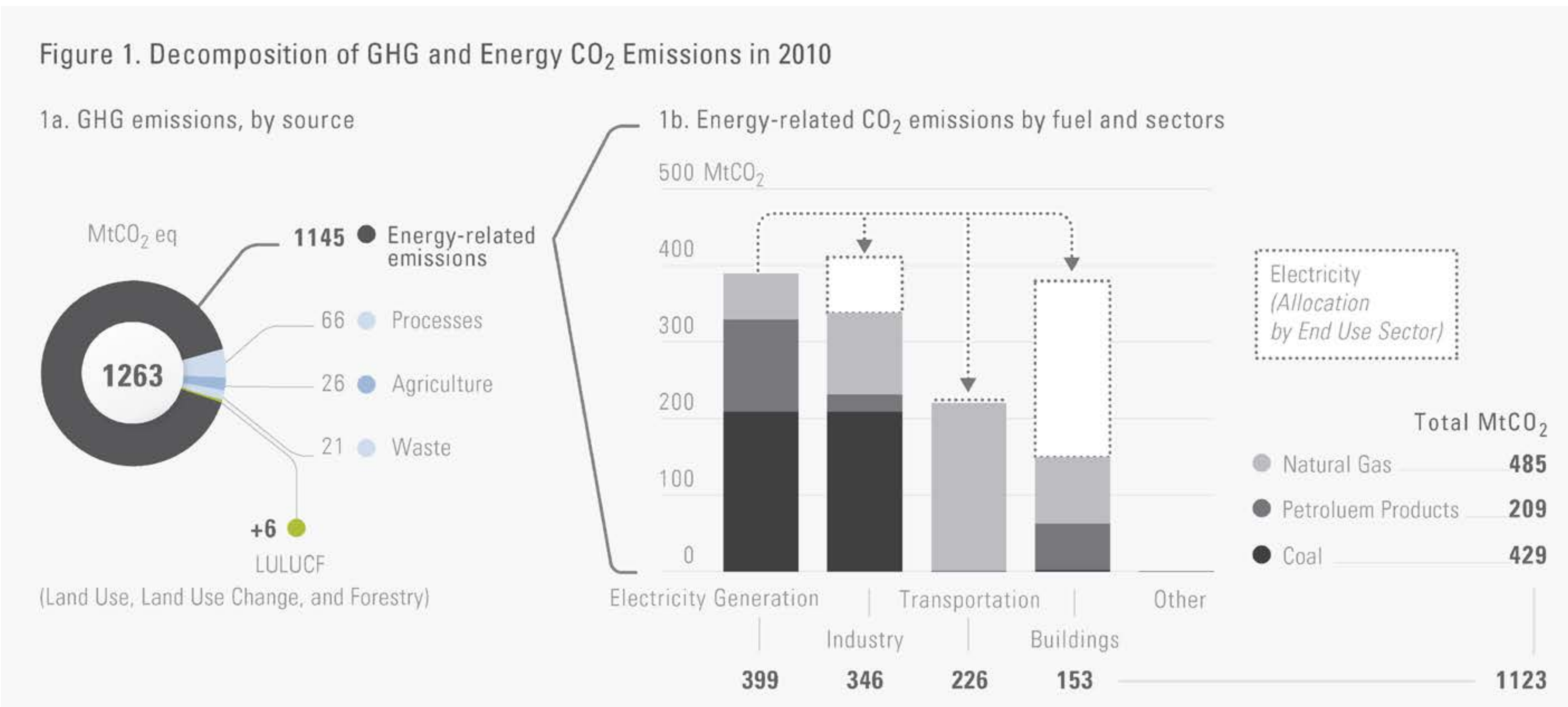
Contents

Background

- Japan's 2050 target : 80% reduction compared to 1990
- After the Daiichi Nuclear Power plant accident in March 2011, availability of nuclear power in the long-term is uncertain.
- To achieve the target with lower nuclear dependence, it is necessary to reduce energy consumption by reducing energy service demands and by increasing the use of energy saving technologies, and to increase the share of renewable energies.

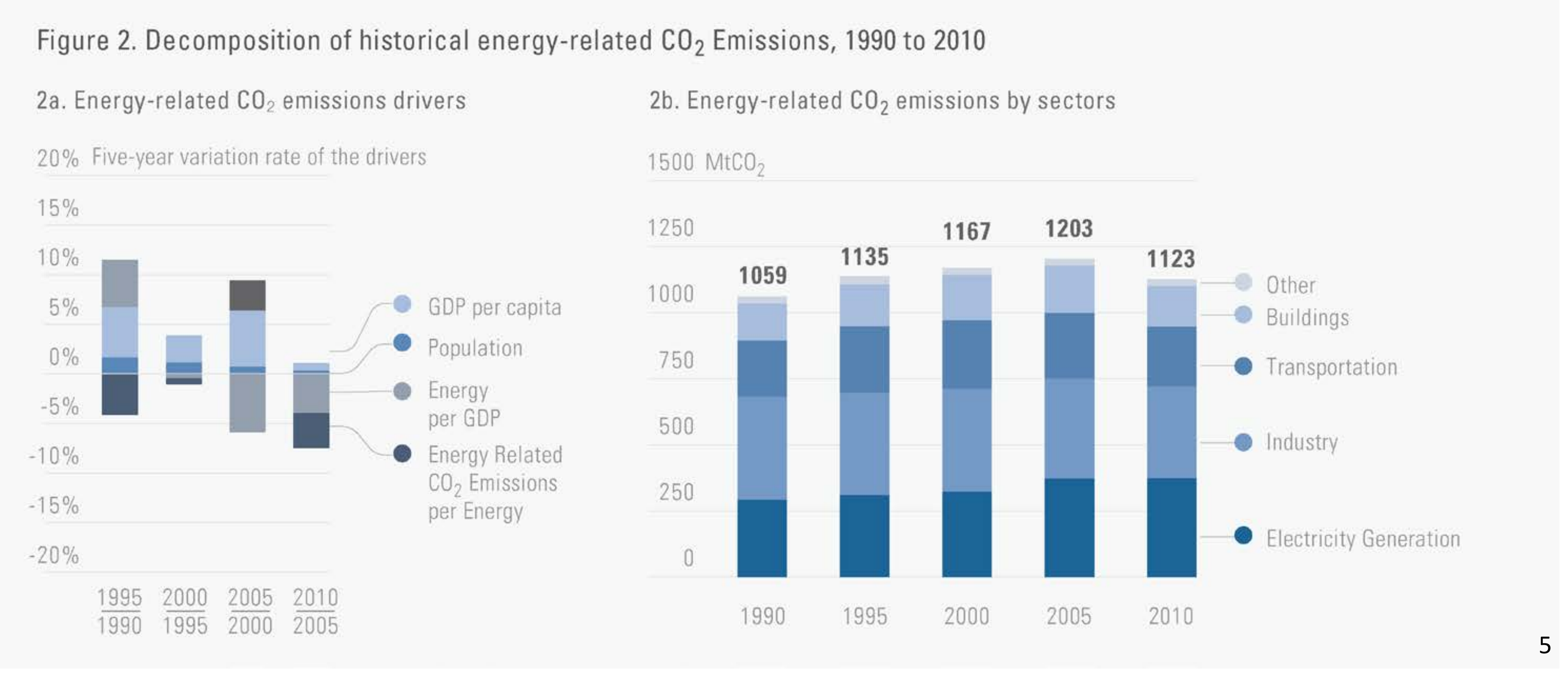
Current Levels of CO_2 emission

- In Japan, Energy-related CO_2 represented a large majority of total GHG emissions in 2010
- Electricity generation and industrial sector were large emitters of direct CO_2 emission
- Emission from Buildings sector is considerable when indirect emission is included.



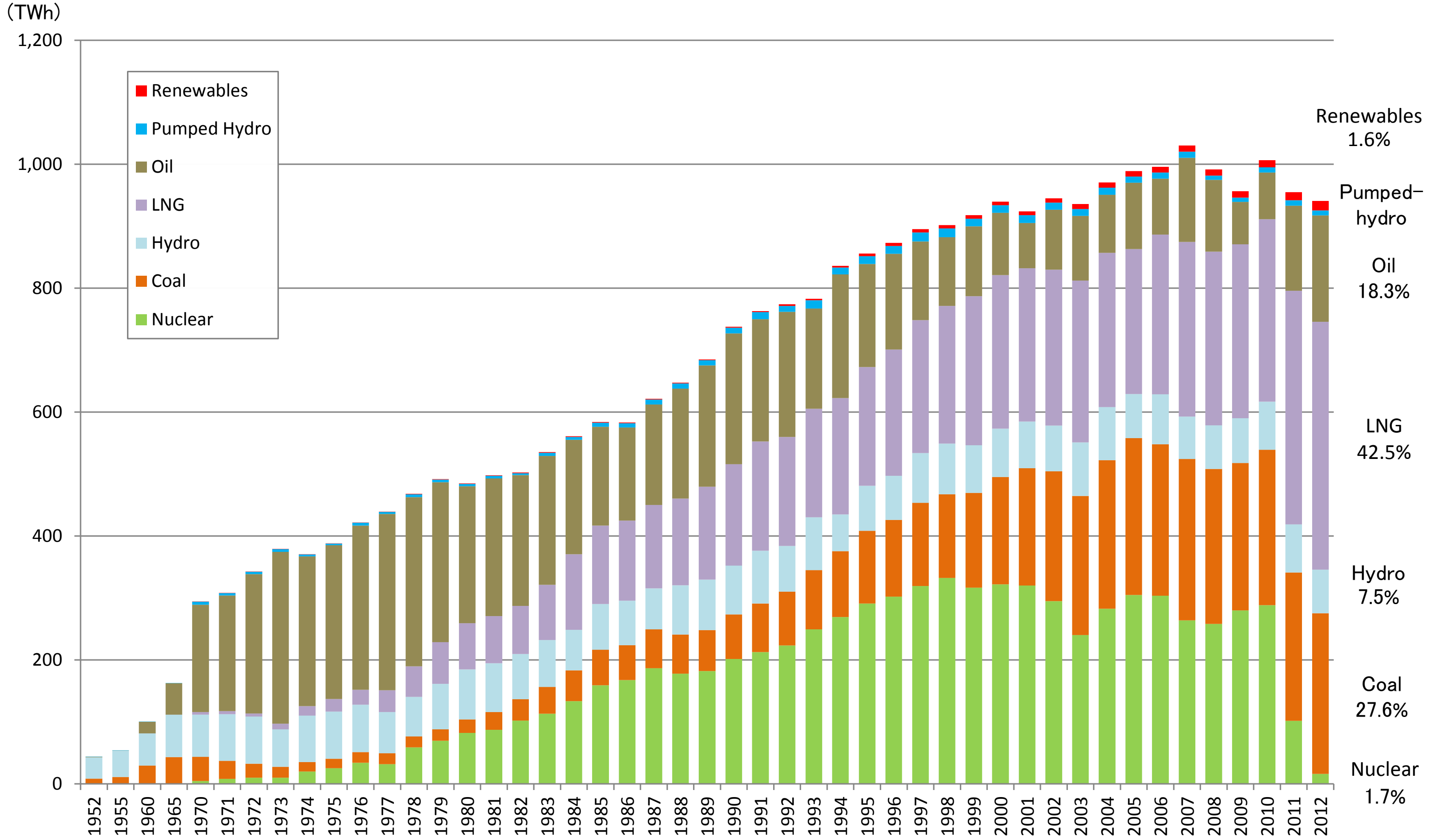
CO_2 Emission Driver

- The Japanese economy has experienced a continuous diffusion of energy efficiency since 2000.
- Until 2007, growth of GDP per capita has been the major driver of CO2 emission increase, while there was a substantial decrease in 2008 and 2009 due to the global economic recession.



Recent Trend in Power Generation

- Power generation from Nuclear power has drastically decreased since 2011.

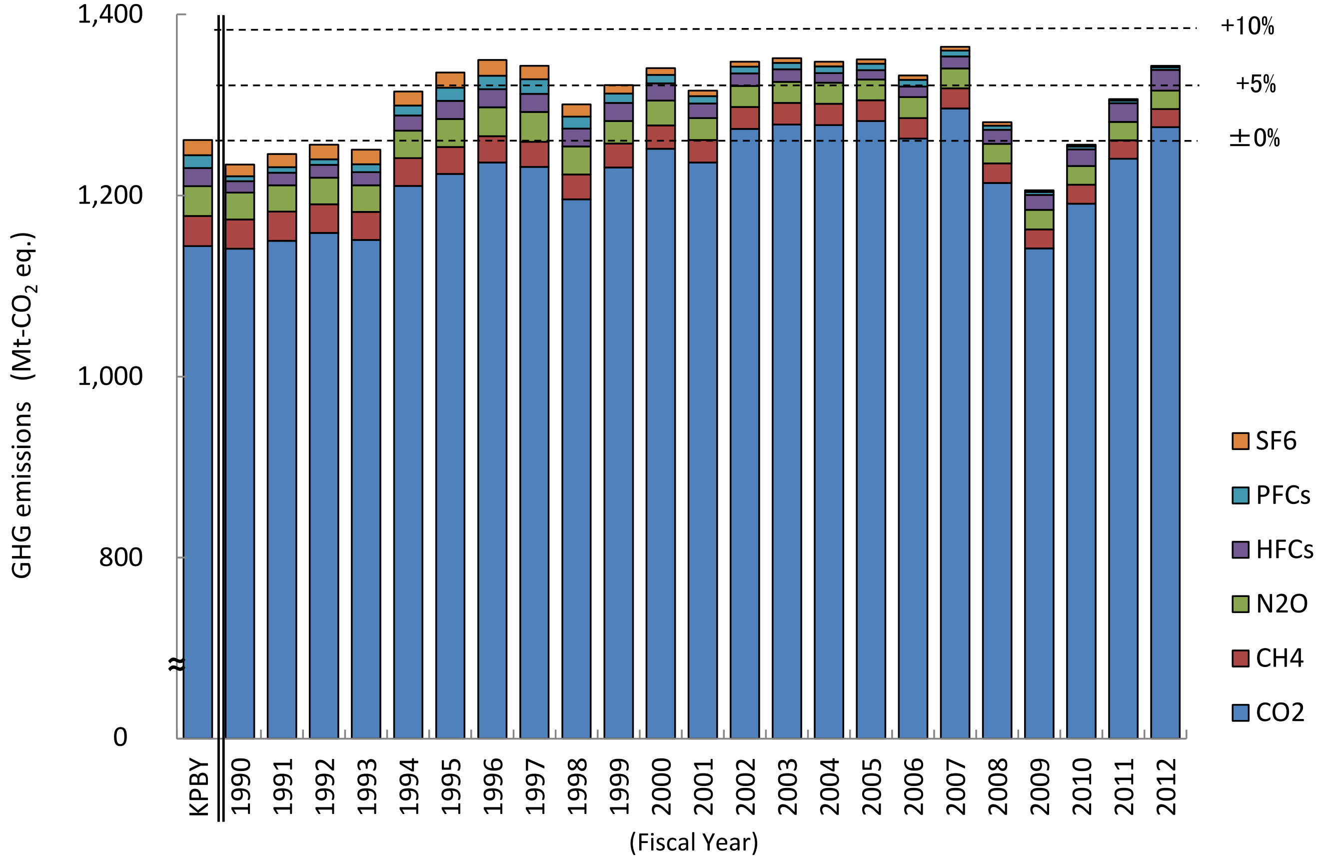


Source: METI, Annual Report on Energy 2014

Recent Trend in GHG emissions

- GHG emission has increased since 2010 due mainly to the suspension of nuclear power.

Trends in GHG emissions (FY1990-2012)



Source: Greenhouse Gas Inventory Office of Japan

※The emissions in the base year of the Kyoto Protocol (KPBY) are those of CO_2, CH_4, N_2O in FY1990 and of HFCs, PFCs and SF_6 in CY1995 reported in the "Report on Japan's Assigned Amount" (submitted in August 2006 and revised in March 2007), and the values do not change during the 1st commitment period. Meanwhile, the emissions in FY1990 and CY1995 to be reported every year can change because of the revision of estimation methodologies or other reasons.

About the Model

- AIM/Enduse Model
  - Dynamic recursive, technology selection model for the mid- to long-term mitigation policy assessment
  - The model applied for the deep decarbonization pathways is a multi-region version of AIM/Enduse model of Japan

- Major low carbon technology options

Electricity generation	Efficiency improvement of power generation, coal and gas with CCS , reduced T&D (Transmission & Distribution) line losses, wind power, solar PV, geothermal, bioenergy
Industry	Energy efficiency improvement, electrification wherever feasible in industrial processes, natural gas use, CCS for iron making and cement lime, fuel economy improvement of agricultural machine, bioenergy use, nitrogen fertilizer management
Buildings	Improvement of the energy efficiency performance of buildings, high-efficiency equipment and appliances, electric heat pump water heaters, energy management system
Transport	Energy efficiency improvement, gas-powered heavy duty vehicles (HDVs), vehicle electrification, hydrogen vehicles

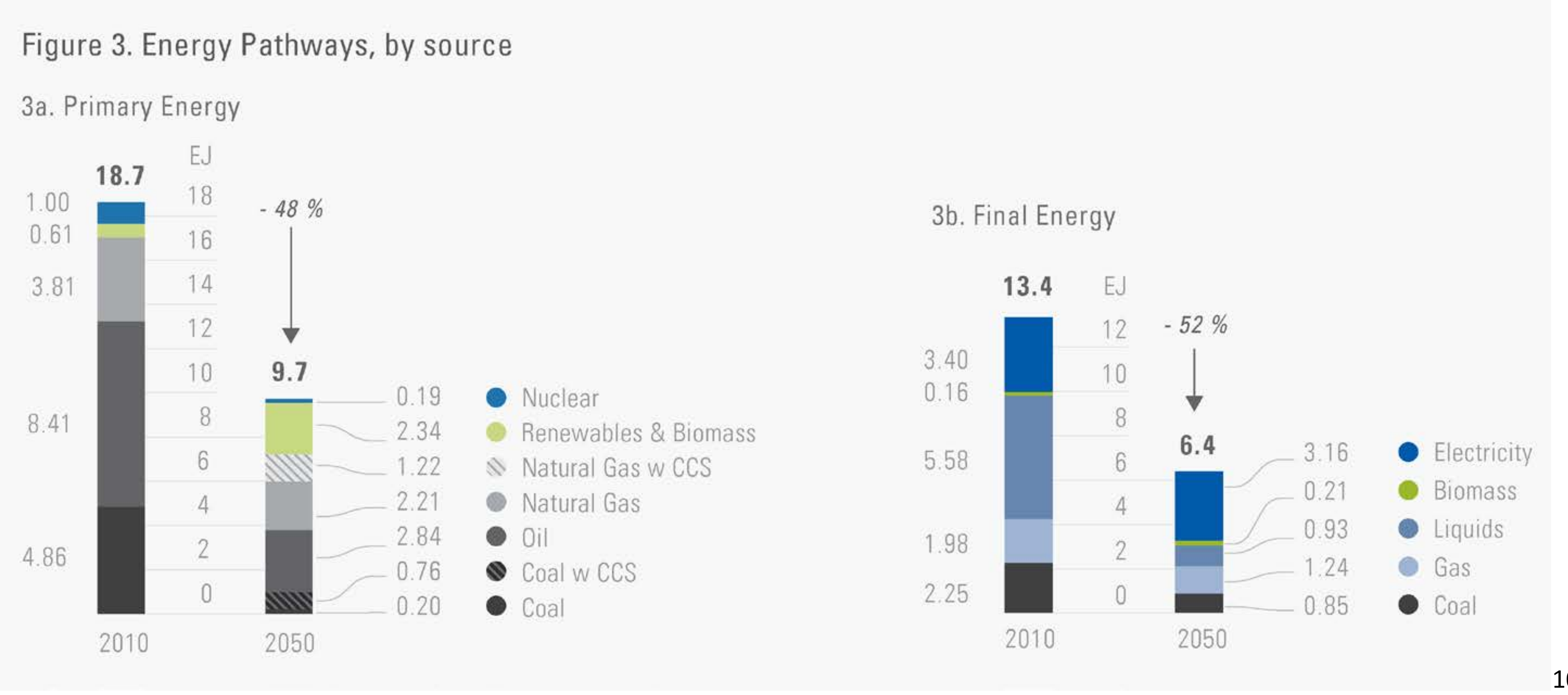
Assumptions

- Nuclear power
  - Lifetime is limited to 40 years for plants built up to 1990 and 50 years for all other plants, and during 2013 to 2035 an additional 3 GW nuclear plants capacity is included.
    (based on the premises of New Policies Scenario of World Energy Outlook 2013 published by International Energy Agency)
  - Subject to these assumptions and maximum capacity factor of 70% for all plants, electricity generation from nuclear plants represents about 50 TWh in 2050.

- Geologic carbon storage potential
  - Complying with previous studies, CCS technologies are assumed to be available from 2025 and annual CO2 storage volume is assumed to increase up to 200 MtCO2/year in 2050.

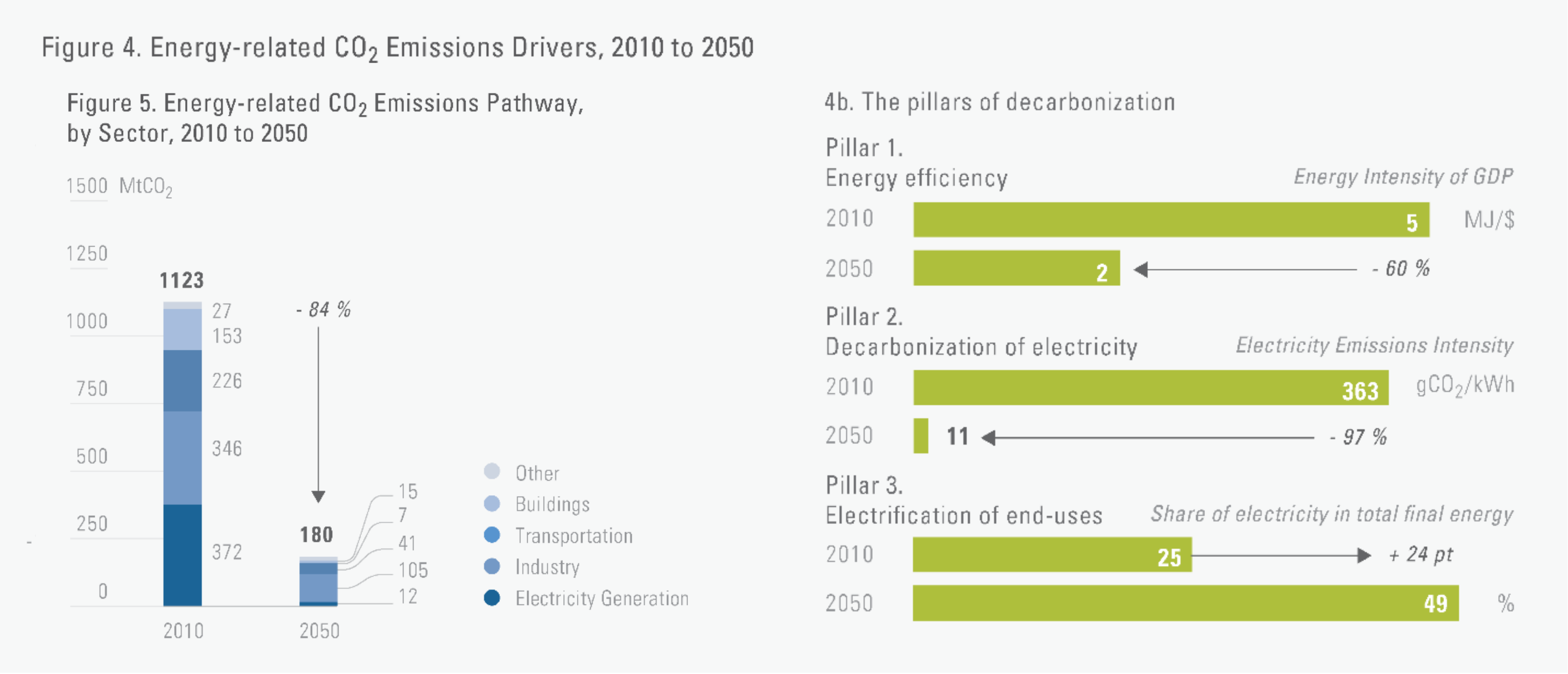
Energy supply and demand in 2050

- Energy Supply and demand in 2050 decreases almost half compared to the 2010 level.
- In 2050, renewables and CCS account for more than 50% of primary energy supply (LHV base).



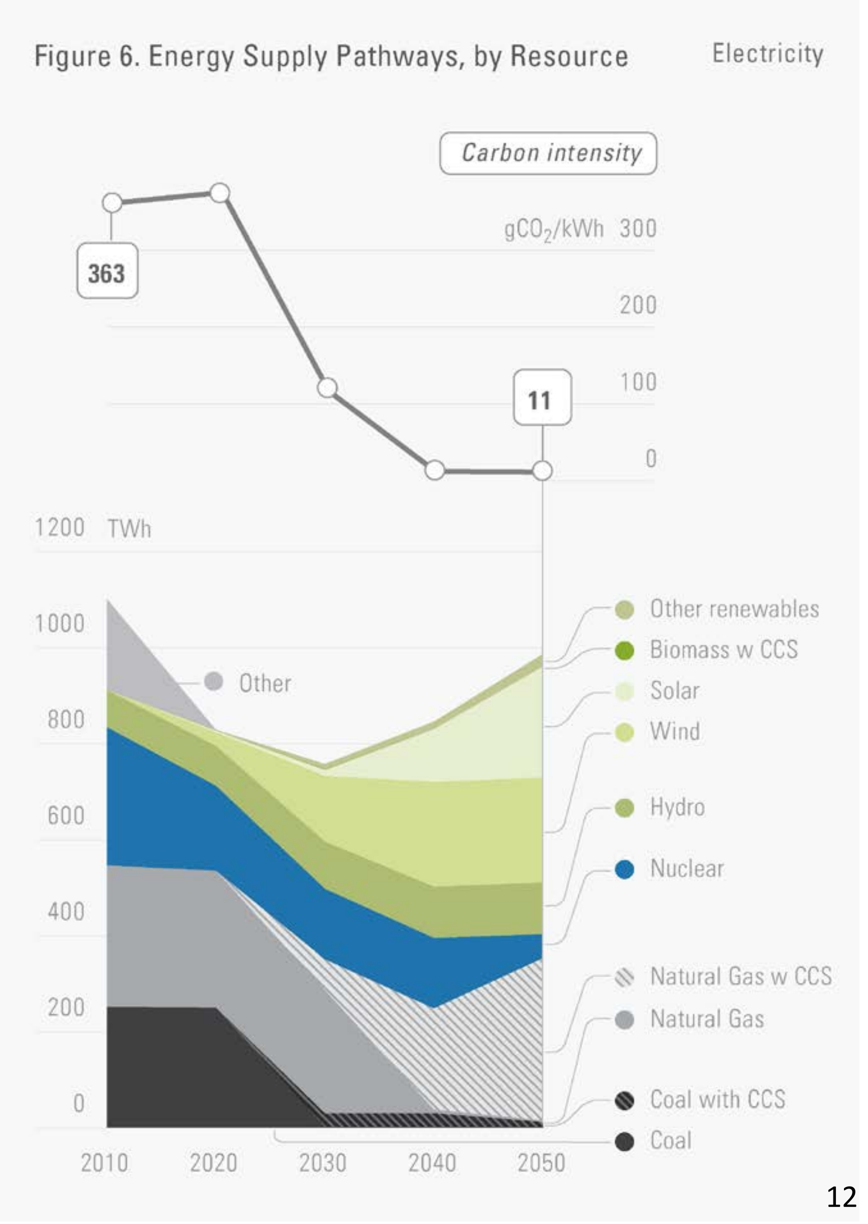
CO_2 emission in 2050

- The long-term GHG emission reduction target is achieved by large scale energy demand reduction and electrification in end-use sector as well as decarbonization in power generation sector including deployment of CCS.



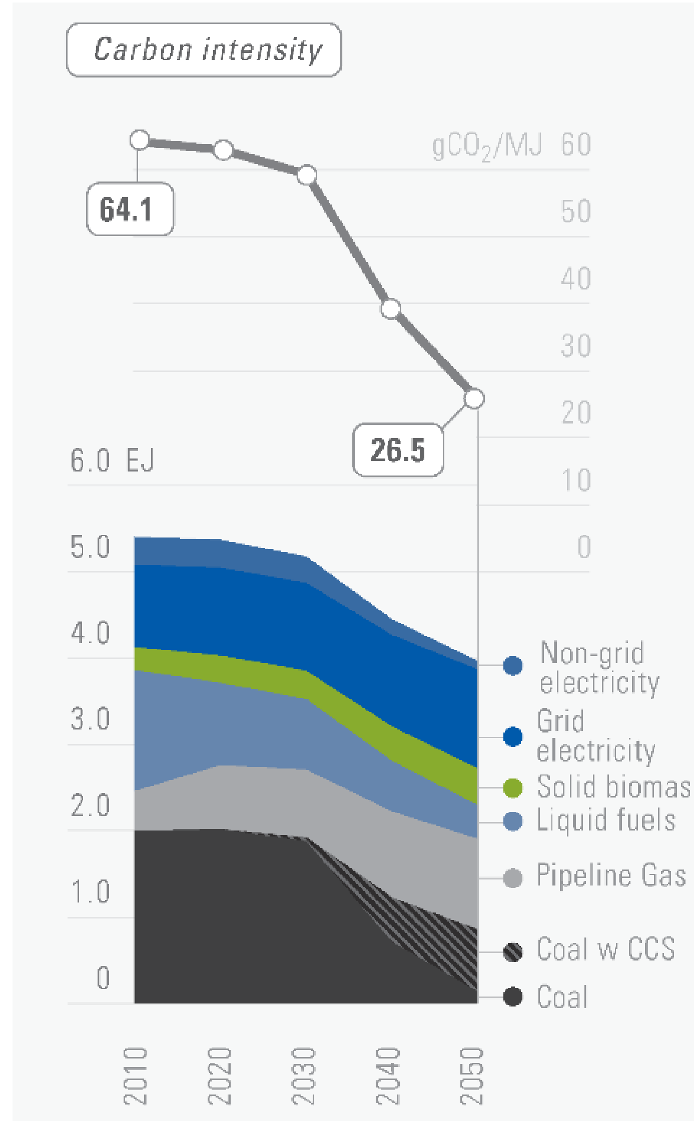
Power sector

- The nuclear power is assumed to be phased out gradually and electricity generation from coal without CCS is entirely phased out by 2050.
- Renewable energy is developed over the mid to long terms and reaches approximately 59% of total electricity generation through large-scale deployments of solar PV and wind power.
- In addition, natural gas (equipped with CCS) is developed to ensure balancing of the network and reaches about a third of total electricity generation in 2050.
- Carbon intensity of electricity falls to nearly zero in 2050.



Industrial Sector

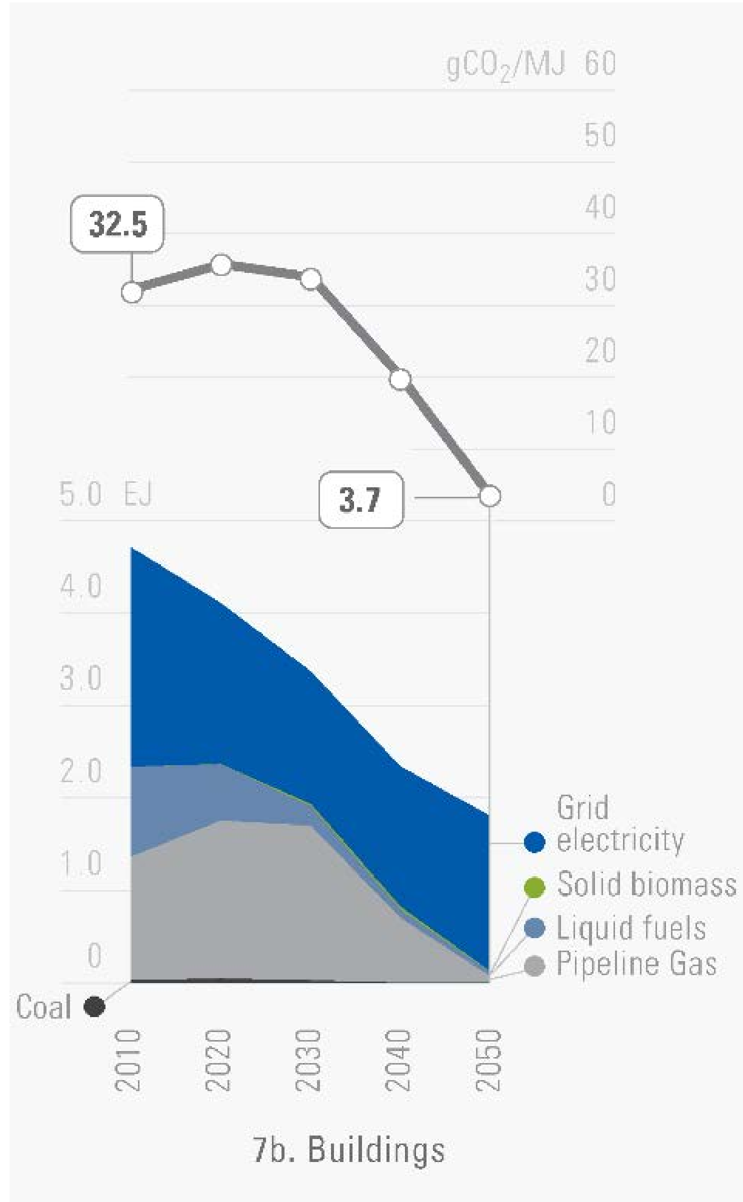
- The industrial sector is the largest emitter: its CO_2 emissions represent about 40% of total GHG emission in 2050.
- Fuel demand for high temperature heat is hardly replaced by low-carbon sources.
- However, carbon intensity is reduced by 60% compared to the 2010 level.



7a. Industry

Buildings sector

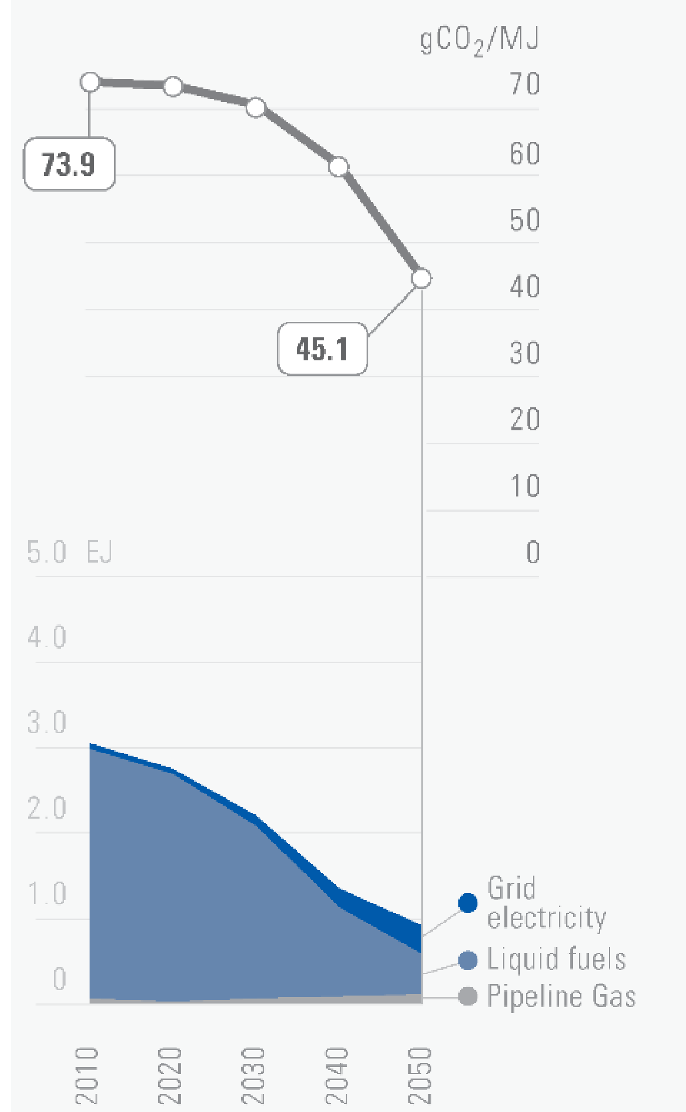
- In Buildings (residential and commercial) sectors, final energy demand is reduced by approximately 60% compared to the 2010 level.
- Electricity becomes the dominant energy over the long term, hence ensuring a significant decrease of the carbon intensity in this sector in 2050.



Transport Sector

- CO_2 emissions in 2050 reduce by almost 80% compared to the 1990 level.

- A combination of energy efficiency, electrification of the fleet, as well as FCEV substitute for oil-based fuels and ensuring a continuous decrease of the carbon intensity of fuels in 2050

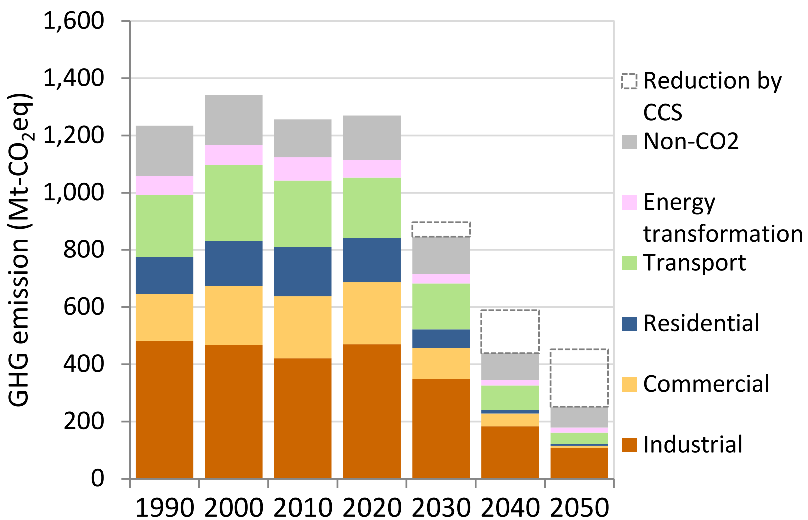


7c. Tranportation

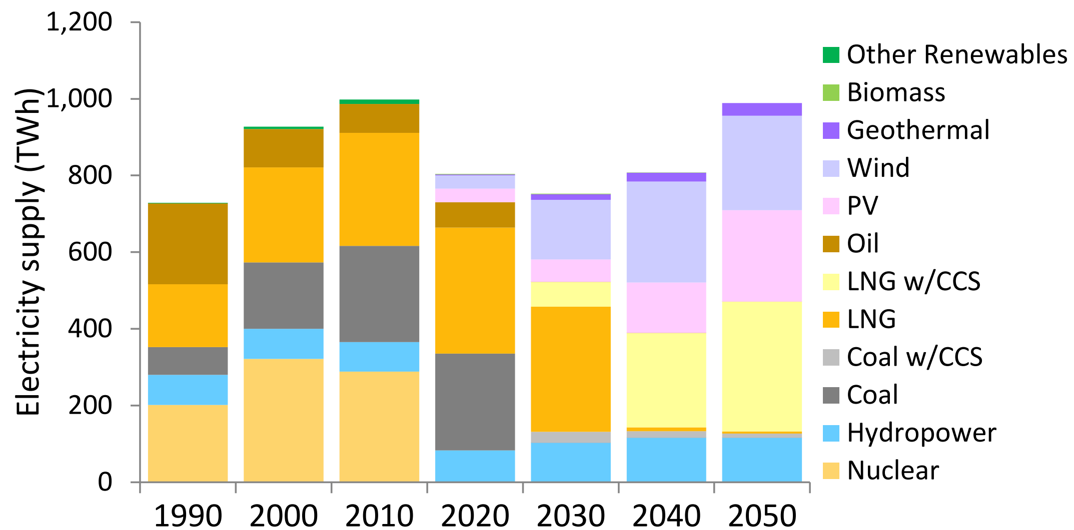
Alternative Pathways – without Nuclear power

- An 80% emission reduction in 2050 is still feasible. However, higher carbon intensity is experienced during the transition period.
- The impact of nuclear phase-out as compared to the illustrative scenario is relatively small in the long term, given the small share of nuclear in 2050 in any case.

GHG emissions



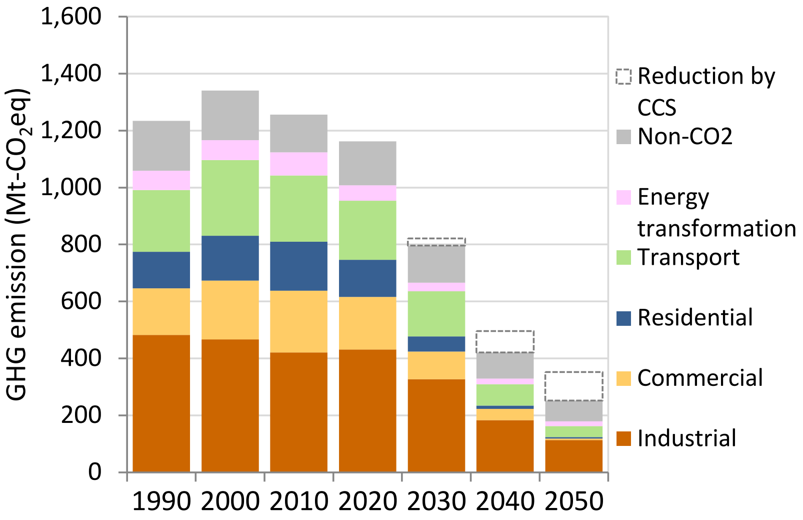
Power Generation



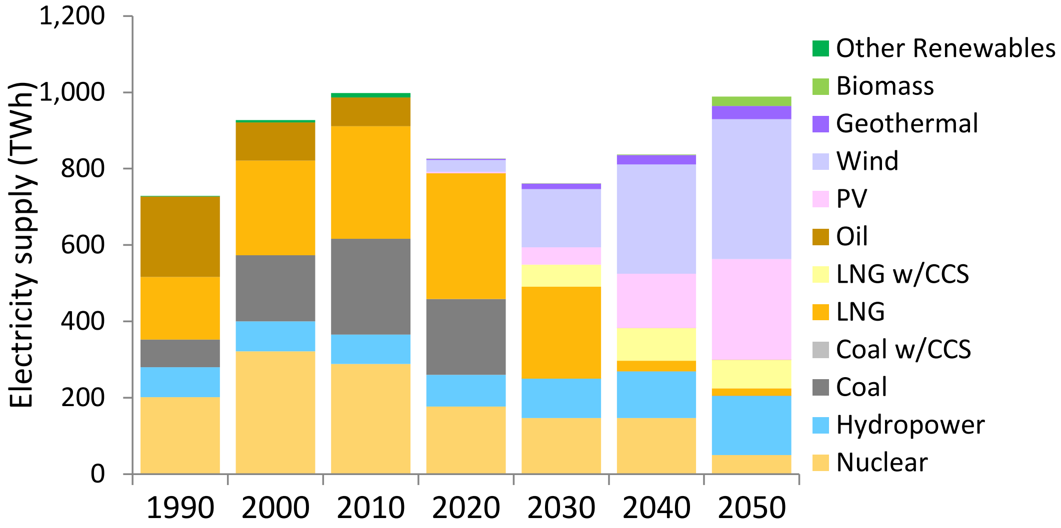
Alternative Pathways – Less CCS deployment

- In this scenario, CO_2 storage volume is limited to 100 $MtCO_2$/year.
- Achieving long-term emission reduction target proves to be still feasible with substantial increase of renewable energy, particularly solar PV and wind power.
- The share of renewable energy in electricity supply reaches approximately 85% in 2050 and variable renewable energies (VREs) account for about 63% in electricity generation in 2050, hence imposing a further challenge for integration into the electricity system.

GHG emissions



Power Generation



Additional measures and deeper pathways

- Further development and diffusion of innovative low-carbon technologies
- Change of lifestyle to reduce energy service demand while maintaining standard of living
- Change of material demand and its energy service demand
- Redevelopment of cities designed to consume less energy
- Relocation of industrial firms where unused energies are easily available

Near-term priorities

- Avoiding lock-in of high carbon intensity infrastructure
- Continuation of electricity saving
- Reducing near-term impact of energy import price by rapid mitigation action

Conclusions

- With large scale diffusion of low-carbon technologies, Japan's long term GHG emission reduction is feasible, even if availability nuclear power and/or CCS is limited.

- However, many challenges remain to achieve deep decarbonization pathway in Japan.
  (e.g. Integrating variable renewable energy into energy system)

- Toward the next phase of DDPP
  - Quantification of the costs and benefits of deep decarbonization pathways